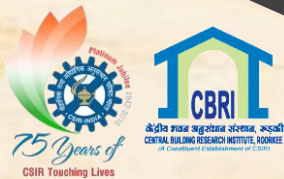


# *CSIR- CBRI TIPS FOR GOOD CONSTRUCTION PRACTICES IN BUILDINGS*



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# CONSTRUCTION MATERIALS



(For details refer IS 3495:1992)

- Use burnt solid clay bricks, solid concrete blocks, hollow clay tiles or hollow concrete blocks.
- Masonry units should be watered for about 4 hours before laying.
- Masonry units should have a minimum of 35 kg/cm<sup>2</sup> compressive strength, uniform shape, size and a maximum of 20% water absorption.



(For details refer IS 383:1970)

- Use hard, clean and crushed aggregates that should be free from any kind of material that could result in deterioration of concrete.
- Use 20 mm down aggregate in footing, plinth beam, bond beam, tie column and slab.



(For details refer IS 1489:1991)

- Do not use cement which is more than 3 months old.
- Store cement in a dry and moisture proof building or shelter and it should be covered with plastic sheets to avoid hardening.
- Stack cement on a platform, 150-200 mm above the floor level.
- Do not open the cement bags until required for usage.



(For details refer IS 2116:1980)

- Use river sand for construction. Do not use sea/beach sand as it may contain salts which could result in corrosion of steel.
- Use well graded sand and it should be free from mud or any kind of dirt, silt or organic matter.



(For details refer IS 2250:1981)

- Use mortar in the ratio of 1:3:0.5 (cement: sand: water) for 115 mm thick masonry walls and 1:6:0.5 (cement: sand: water) for 230 mm thick masonry walls.
- Adequate quantity of water should be added such that sufficient workability in mortar is achieved during its application.



(For details refer IS 1199:1959)

- Use minimum M20 (1:1.5:3) grade of concrete in foundation, plinth beam, bond beams, tie columns and slab.
- Use super-plasticizer in concrete mix to achieve adequate workability.



(For details refer IS 1786:2008)

- Use Fe 415 or higher grade of steel as reinforcement.
- Do not use corroded, old or bent bars.
- Store reinforcement bars on a platform to prevent corrosion.
- Apply cement slurry over rebar to protect from corrosion.



(For details refer IS 3025:1987)

- Use potable water for mixing and curing, which should be free from organic matter, oils, acids, salts or any other substance that could result in deterioration of concrete or steel.

# ON- SITE MATERIAL QUALITY TESTS

## BRICKS

- Take 6 random samples of bricks and calculate its average dry weight. Immerse bricks in water for 24 hrs, then again calculate their average weight. The difference in final average weight and initial average weight indicates the amount of water absorbed by the bricks. It should not exceed 20% of average weight of dry bricks.
- Closely observe bricks for uniformity of their shapes, size and colour. Bricks should be rectangular in shape with sharp edges.
- Put a scratch on the brick surface with finger nail. For brick to be hard enough, no impression or mark should be visible on the surface.
- Gently struck two bricks with each other. A good quality brick will not break and will generate a metallic sound.
- Break a brick and examine its structure. It should be homogeneous, compact and free from holes and lumps.
- Conduct compressive strength tests on randomly selected brick samples. (Refer IS 3495: (Part 1) – 1992)

## CEMENT

- Open the bags to check the presence of lumps. Presence of lumps is the indication that setting has started, and thus that cement shall not be suitable.
- Take a pinch of cement and rub it between fingers. It should give a smooth texture, otherwise if it is rough, it indicates that the cement is adulterated with sand.
- Smell a pinch of cement. If it gives an earthy smell, it indicates that cement is adulterated with clay and silt.
- Put a small quantity of cement in a bucket of water. Cement should sink and must not float on water.
- Cement should be uniform in colour. Colour of cement is grey with a light greenish shade.

## SAND

- Take a transparent glass, half filled with water. Add sand,  $\frac{1}{4}$ <sup>th</sup> volume of glass in water and shake vigorously. After a minute, a distinct layer of settled silt and sand will be noticed. Measure its depth and calculate percent of silt content, which should be limited to 5%.
- Rub a pinch of sand between the fingers. If fingers get stained, it indicates that the sand is adulterated with the earthy matter.
- Add solution of caustic soda in sand to detect the presence of organic impurities. If the colour of solution changes into brown, it indicates the presence of organic impurities.

## REINFORCEMENT

- The bend test should be carried out with bending devices as specified in IS 1599: 1985. Absence of cracks in rebar shall be considered as the evidence that the test piece withstood the bend test.
- The tensile strength test and elongation of steel should be carried out with reference to IS 1608: 2005. Tensile strength obtained from the test should be equal to the strength specified by the manufacturer.
- The pull-out test should be carried out to determine the bond stress in rebar. The rebar specimen should be placed in testing machine such that the bar is pulled axially from the cube. The test procedure should be followed and bond stress should be calculated in accordance with IS 2770 (Part 1): 1967.





# CONSTRUCTION PRACTICES

## CONCRETE

- Mix cement, sand, coarse aggregate, water and super plasticizer as per the mix design.
- Concrete mix should be consumed within 30 minutes after preparation.
- During casting, concrete should be properly mixed and compacted by mechanical means.
- Exposed surfaces of casted concrete should be properly cured; either by ponding or by covering with wet hessian cloth for a minimum of 7 days.

*(For details refer IS 456: 2000, IS 10262: 2009, IS 1199: 1959, IS 2386: 1963, IS 516: 1959)*

## MASONRY

- Provide 10 mm thick mortar in joints of masonry courses.
- Maximum 1.2 m high brickwork should be carried out in one day.
- Fill gap between masonry and beam soffits just before plaster.
- Provide 8 mm reinforcement bar in 115 mm masonry walls after every fourth course.
- The joints and edges should be properly formed and excessive mortar from the joints should be neatly removed by a trowel.
- Restrict length/thickness ratio of wall to 20. Otherwise provide pilaster (brick column) to fulfill this requirement.
- Masonry walls should be cured for 7 days.

*(For details refer IS 3495: 1992, 1077: 1992, IS 2212: 1991, IS 6042: 1969, IS 3012: 1971)*

## MORTAR

- Mortar should be prepared using measuring boxes and the mixing of mortar should be done in mortar pan in designed proportions.
- Mix cement and sand properly so that it gives uniform color and workable consistency.
- First prepare dry mix of mortar (cement and sand) in adequate quantity and add water in appropriate quantity when required, so that wet mortar mix can be utilized within 30–45 minutes.
- The mortar used in masonry should not contain excessive water.

*(For details refer 2250: 1981 IS, IS 3085: 1965)*

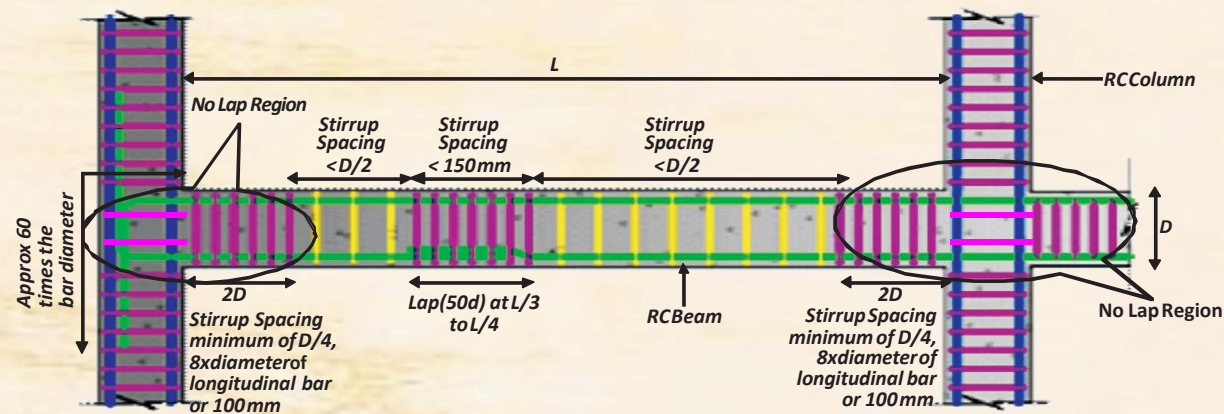
# REINFORCEMENT DETAILING

## STIRRUPS

- The reinforcement detailing of stirrups should be provided as shown in the figure.
- Ensure that stirrups are properly tied with binding wires.

## BEAM

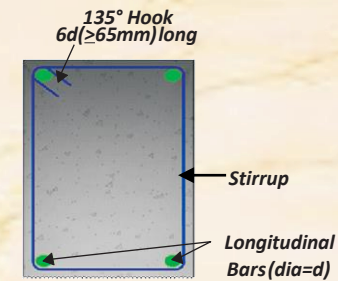
- The reinforcement detailing in beams should be provided as shown in the figure.
- Lap splices should not be provided within a joint. The laps may be provided in  $L/3$  to  $L/4$  region of beam. Lap length should not be less than the development length. Not more than 50% of the cross-sectional area of bars should be spliced at any section.
- Place longitudinal bars carefully with adequate concrete cover of 25 mm.



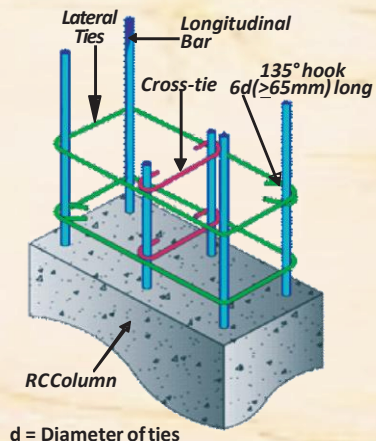
Reinforcement Detailing in RC Beam

## COLUMN

- The reinforcement detailing in columns shall be provided as shown in the figure.
- Place longitudinal bars carefully with adequate concrete cover of 40 mm.
- The laps in longitudinal reinforcement of column shall be spliced in mid-half length and confined with ties at 150 mm spacing. Not more than 50% cross-sectional area of bars shall be lapped at a section.
- The detailing of reinforcement in beam-column joints at end span shall be as shown in the figure.
- Provide cross-ties if parallel legs of lateral ties are spaced at a distance of more than 300 mm c/c.
- Mechanical splicing shall be adopted for bars of diameter larger than 32 mm.



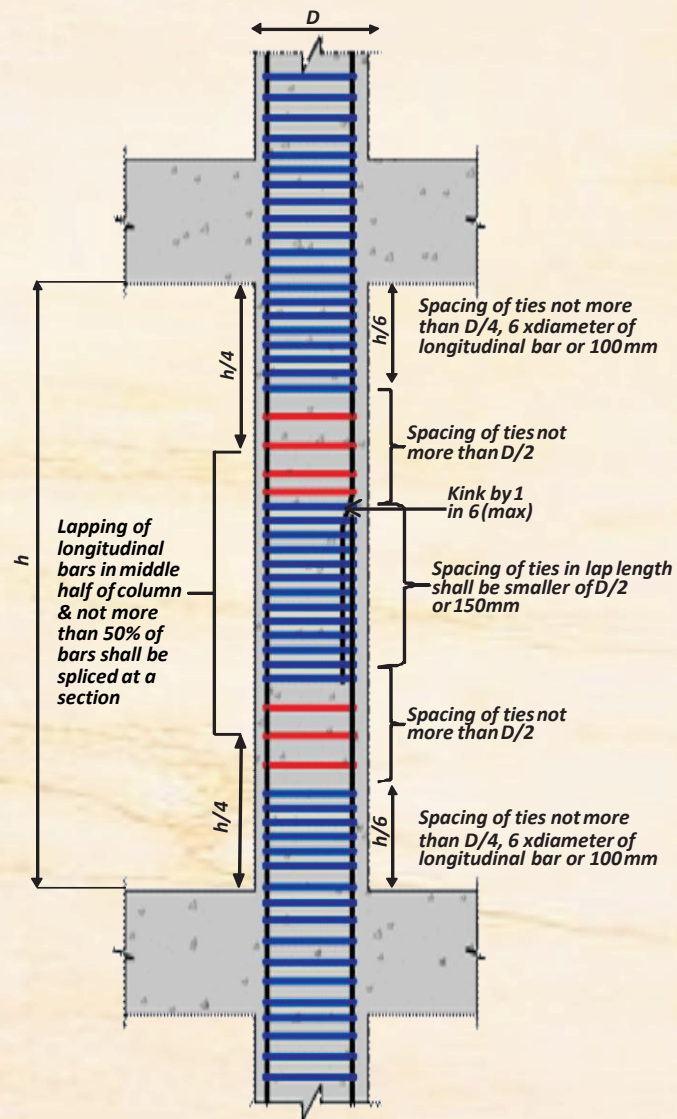
Stirrup Detailing



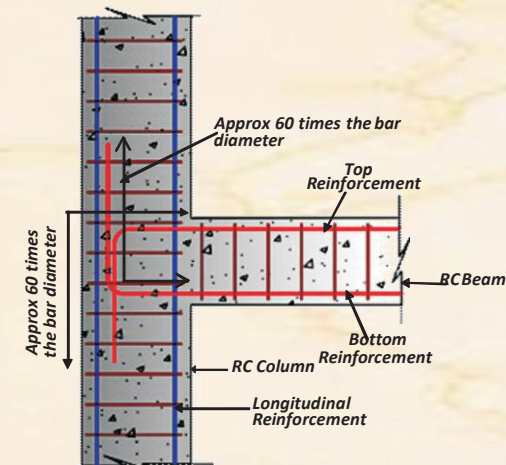
$d$  = Diameter of ties

Cross Tie and 135° Hook in Lateral Ties

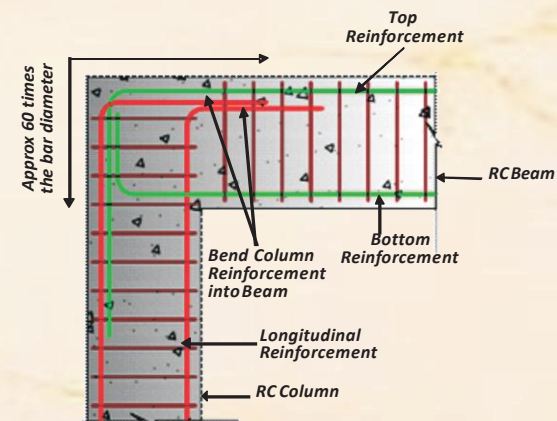
# REINFORCEMENT DETAILING



Reinforcement Detailing in RC Column



At Intermediate Floor End Span



At Roof Floor End Span

At Beam-Column Joint



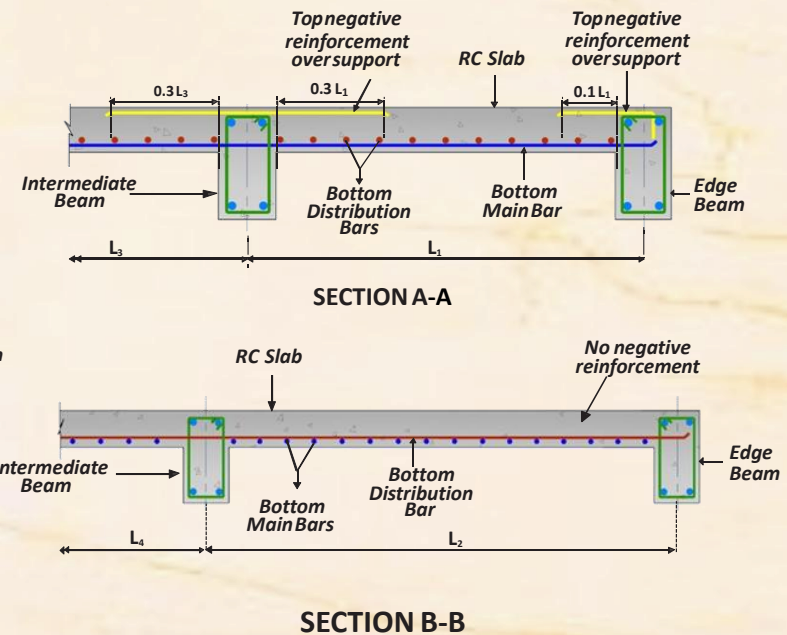
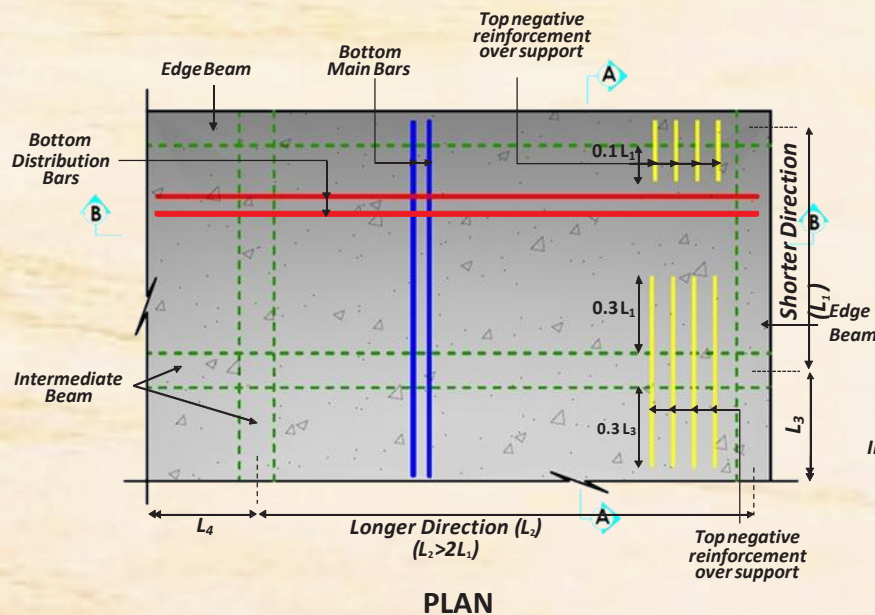
# REINFORCEMENT DETAILING

## SLAB

- The reinforcement detailing in slabs shall be provided as shown in the figure below.
- Cranks in slabs are not permitted due to poor performance in seismic shaking.
- Minimum slab thickness shall be 100mm.
- Generally, slab thickness shall be calculated as shorter span/28 or 100 mm, whichever is higher.
- The minimum cover to reinforcement shall be not less than 15 mm, nor less than the diameter of bar.

## One- Way Slab

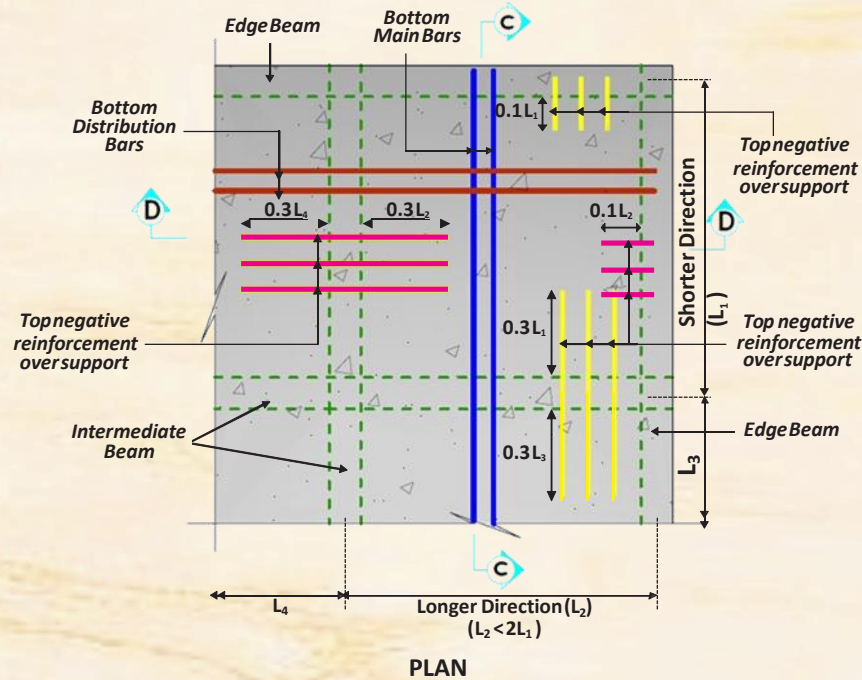
(When ratio of longer span to shorter span of slab is greater than 2)



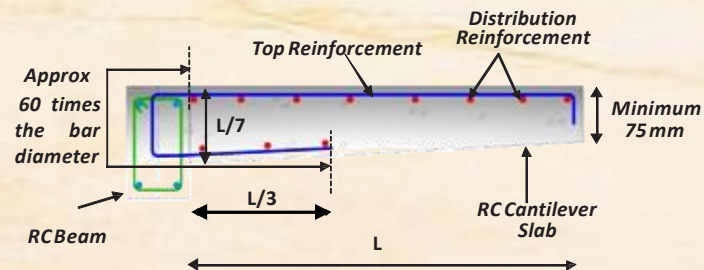
# REINFORCEMENT DETAILING

## Two - Way Slab

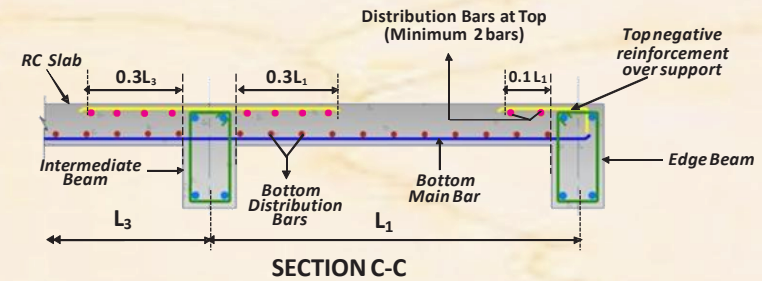
(When ratio of longer span to shorter span of slab is less than 2)



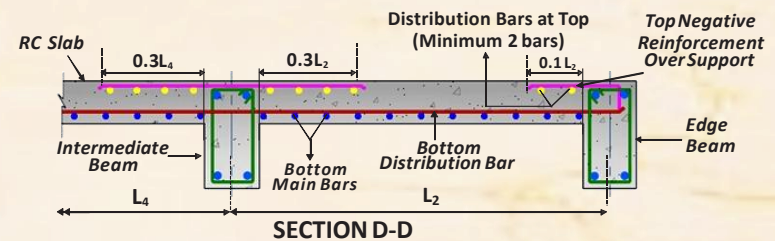
PLAN



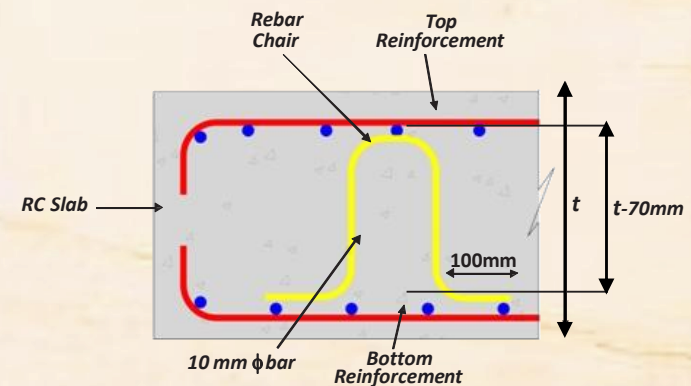
Cantilever Slab from Beam



SECTION C-C



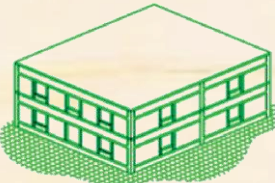
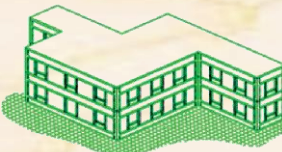
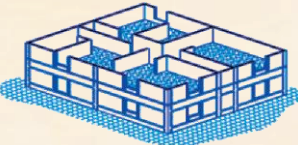



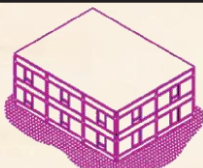
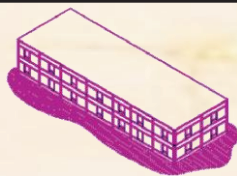
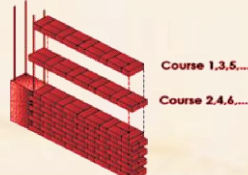
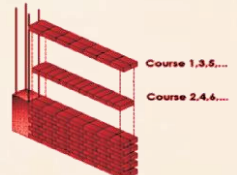
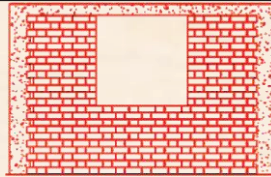

SECTION D-D



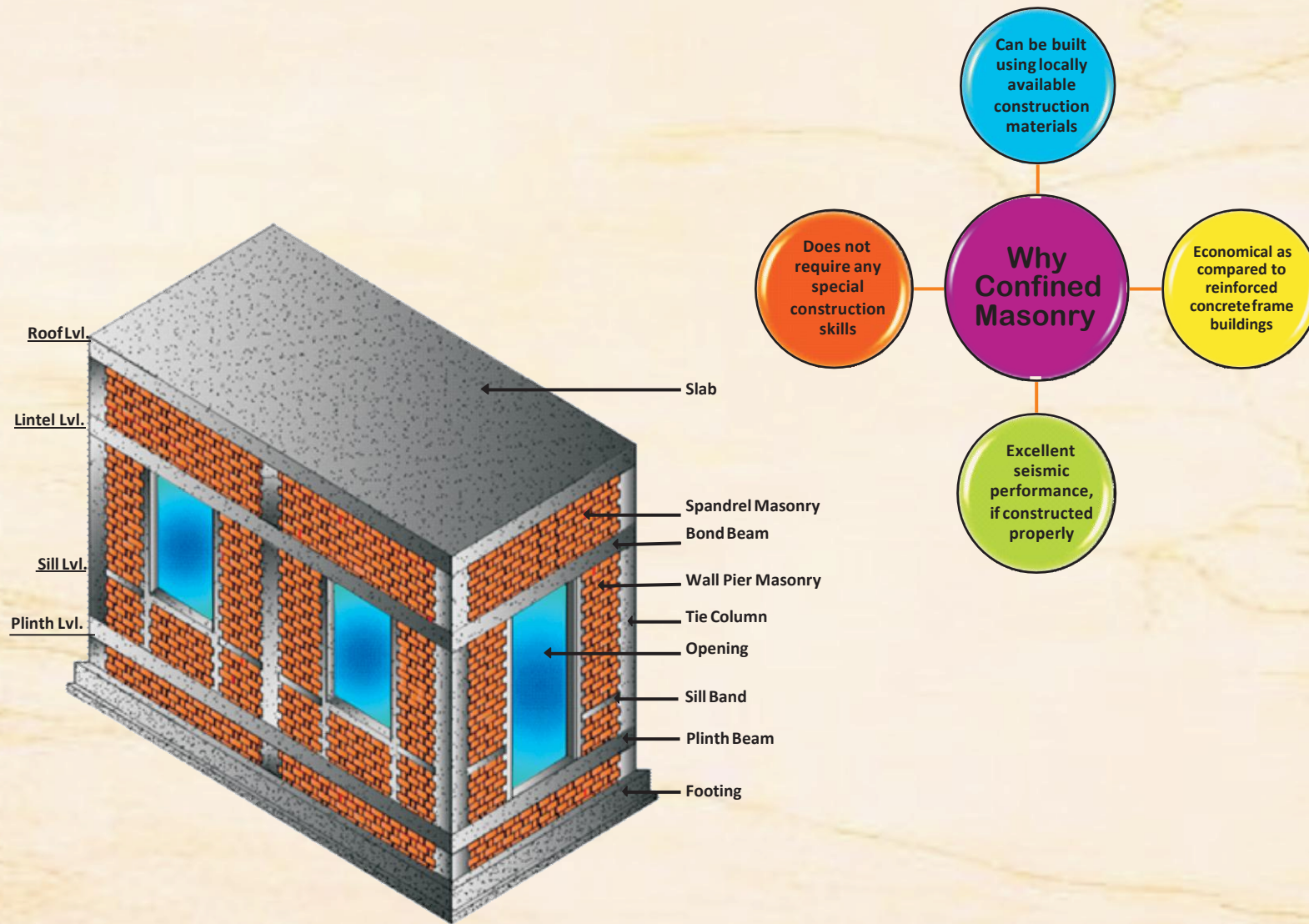
Rebar Chair in Slab Reinforcement



# PLANNING ASPECTS

	✓ Good Practice	✗ Bad Practice
<b>Building Shape</b> <ul style="list-style-type: none"> <li>➤ Shape should be regular.</li> <li>➤ Avoid L, U, Y etc. Shape buildings.</li> <li>➤ If unavoidable, give separation gap to form regular shape.</li> </ul>		
<b>Symmetrical Walls</b> <ul style="list-style-type: none"> <li>➤ Provide more-or-less symmetrical walls in both the directions of the plan.</li> </ul>		
<b>Vertical Continuity</b> <ul style="list-style-type: none"> <li>➤ Walls should be continuous in elevation upto the foundation.</li> </ul>		
<b>Plan Dimensions</b> <ul style="list-style-type: none"> <li>➤ Length to width ratio of the plan should be less than 4.</li> </ul>		
<b>Masonry Bond</b> <ul style="list-style-type: none"> <li>➤ Flemish bond is preferred as compared to english or any other bond.</li> </ul>		
<b>Wall Opening Proportion</b> <ul style="list-style-type: none"> <li>➤ Restrict upto 40% of wall surface for openings.</li> <li>➤ Openings shall be preferably be in mid span, away from corners.</li> </ul>		

# WHY CONFINED MASONRY

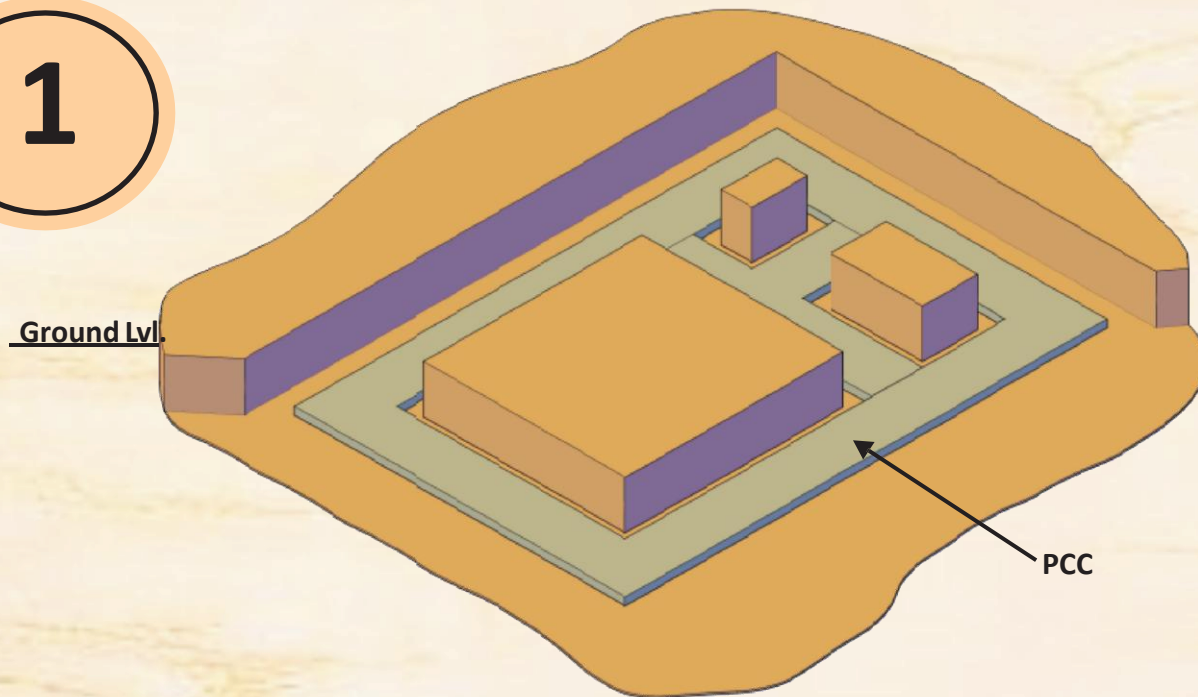


Typical Confined Masonry Building

# CONSTRUCTION METHODOLOGY

(Cost Effective, Seismic Resistant Confined Masonry Building)

1



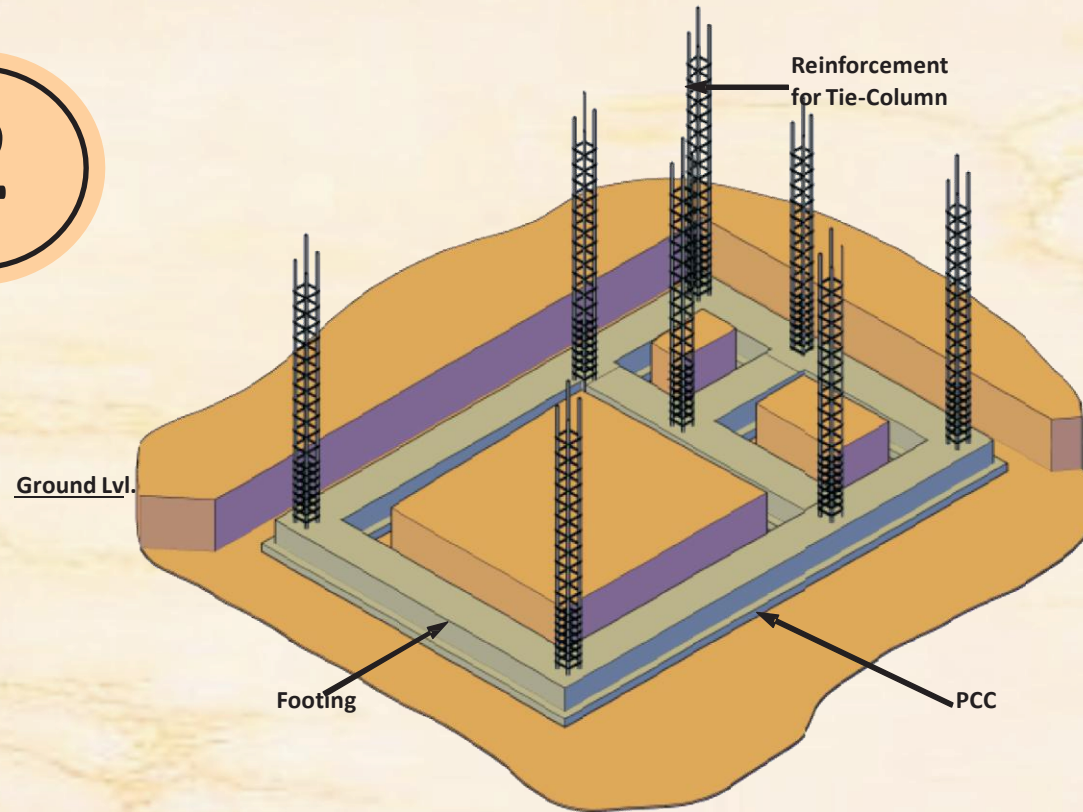
Excavate upto adequate foundation depth/width along the walls of the building and lay 100 mm thick PCC as levelling course.



# CONSTRUCTION METHODOLOGY

(Cost Effective, Seismic Resistant Confined Masonry Building)

2

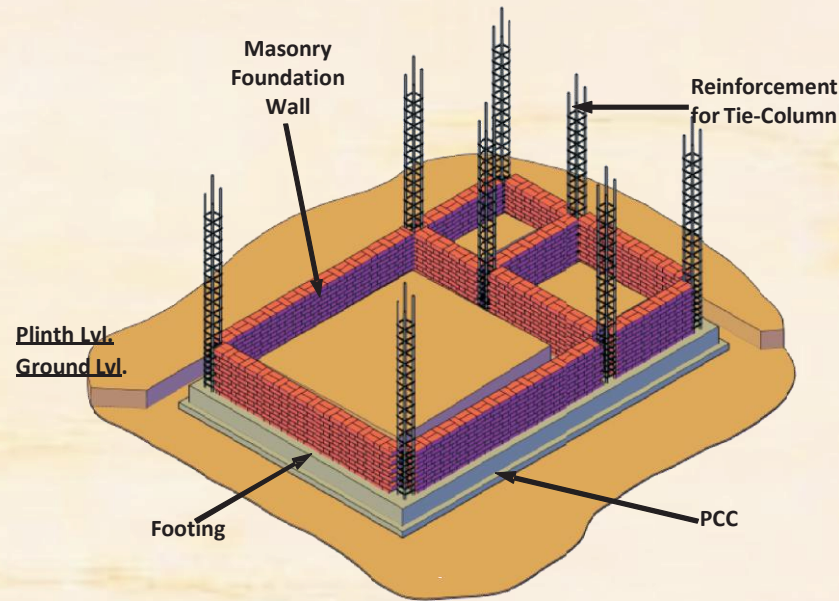


Cast footing beneath the walls and erect tie-columns reinforcement as per layout. Provide tie-columns at every corner of room and wall intersection. Limit maximum spacing of tie-column to 4.2 m. Provide reinforcement cage for tie-columns above the roof level.

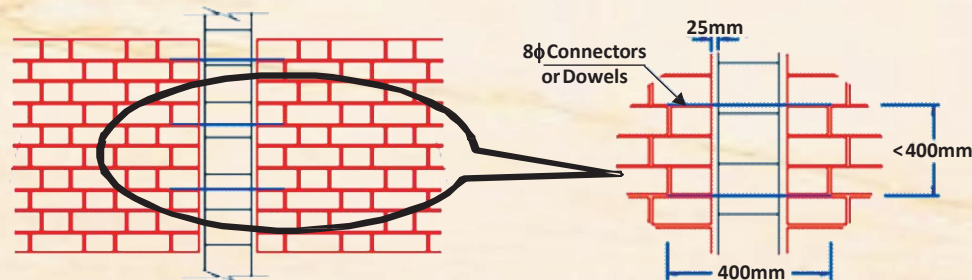
# CONSTRUCTION METHODOLOGY

(Cost Effective, Seismic Resistant Confined Masonry Building)

3



Construct plinth masonry wall upto the plinth level leaving apart the column spaces with 25 mm groove at wall ends. Alternatively, follow arrangement as given below.

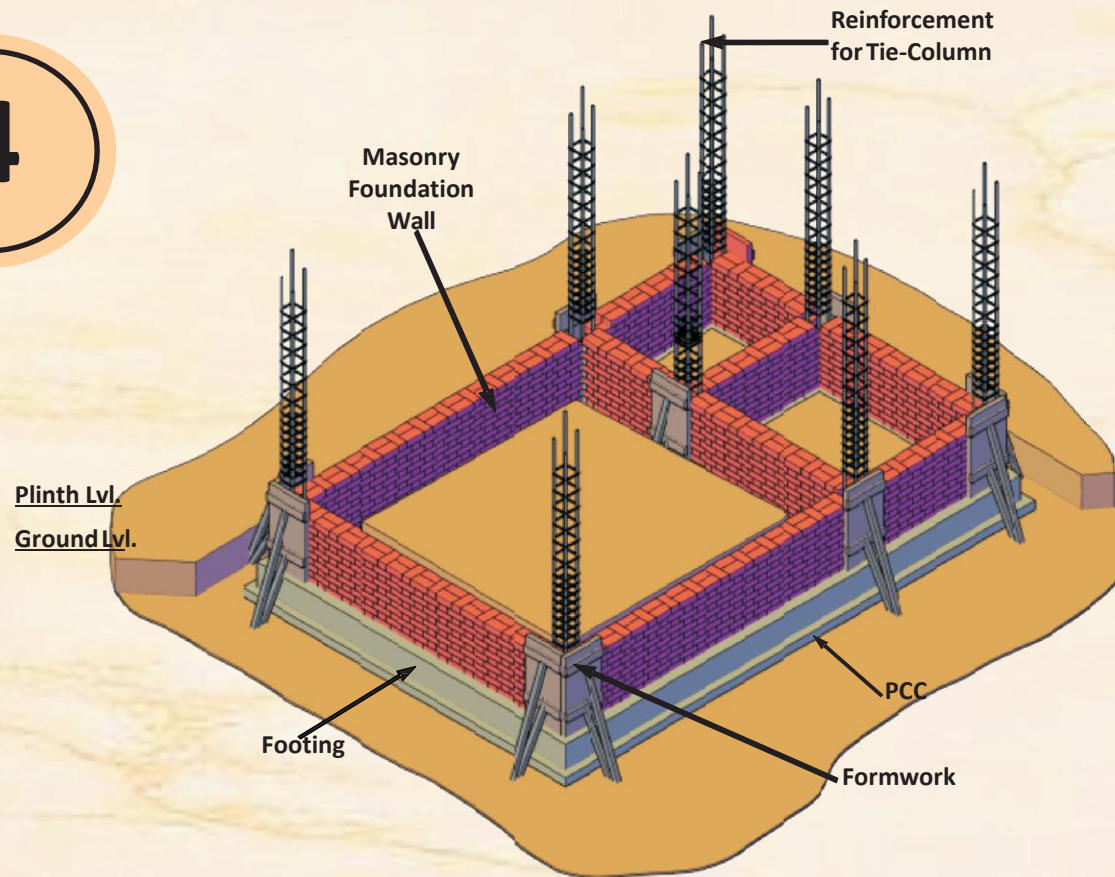


This will ensure better bond between RC Tie-column and masonry.

# CONSTRUCTION METHODOLOGY

(Cost Effective, Seismic Resistant Confined Masonry Building)

4



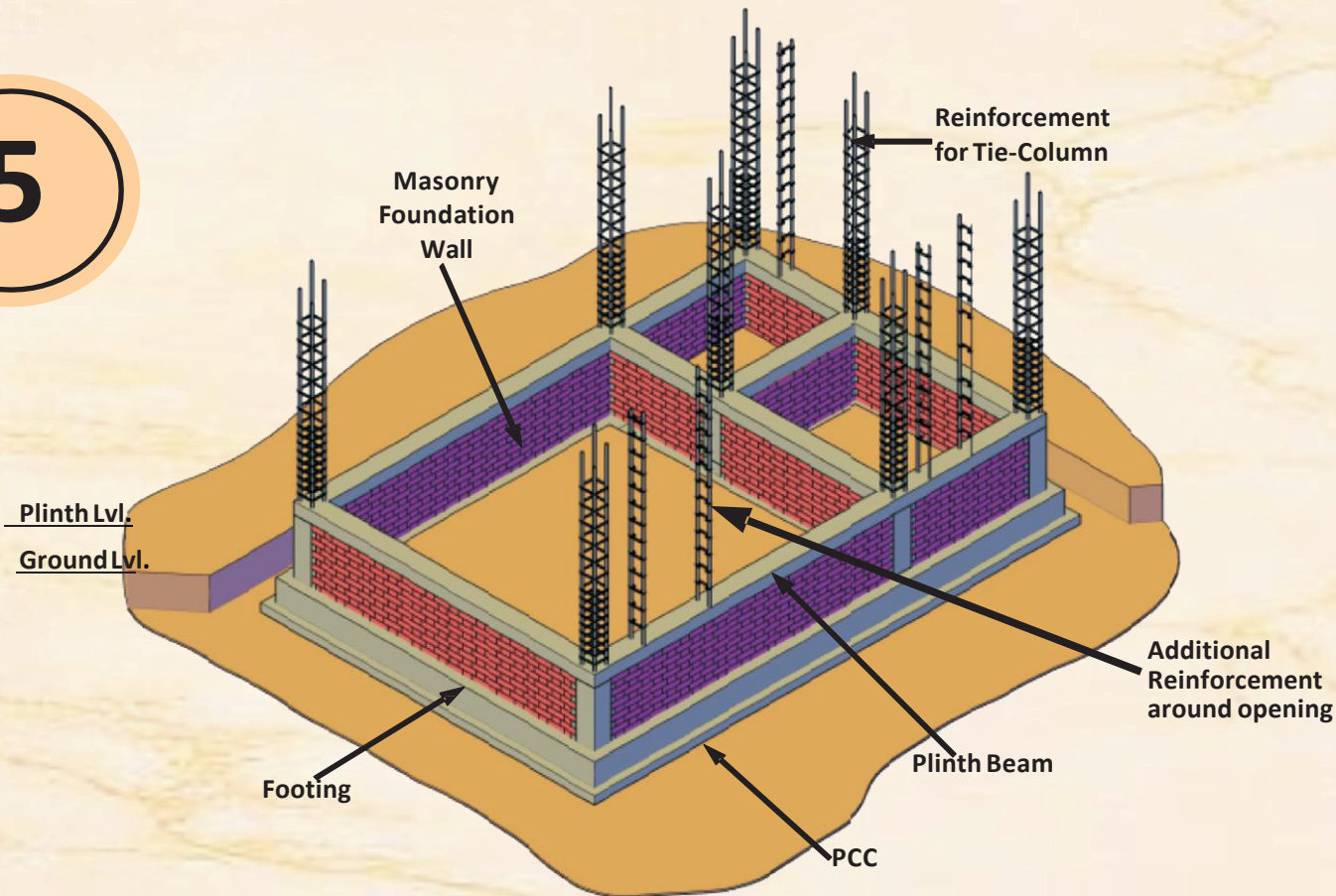
Upon constructing maximum 1.2 m wall height, provide formwork for tie-columns upto the plinth level.



# CONSTRUCTION METHODOLOGY

(Cost Effective, Seismic Resistant Confined Masonry Building)

5

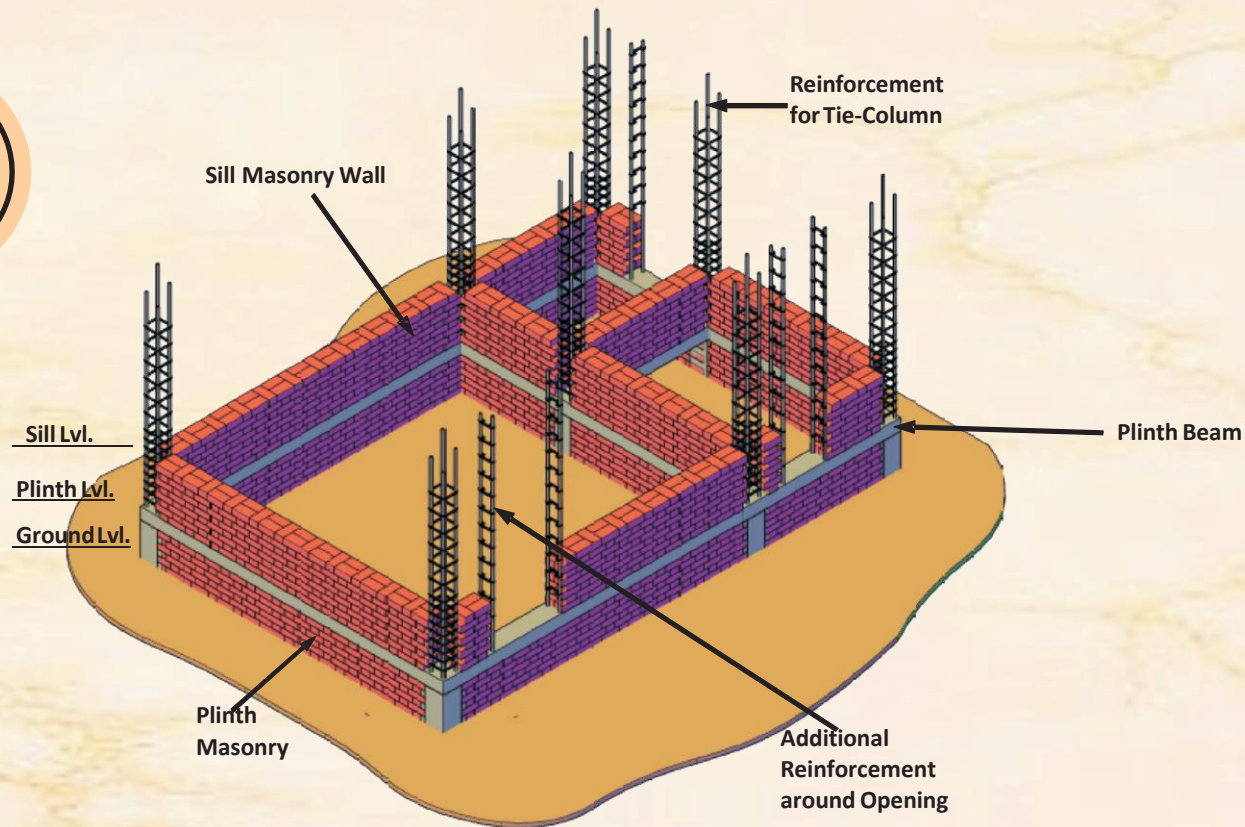


Cast tie-columns from foundation level upto the plinth level along with the plinth beam, carry out earth fill with maximum 15% moisture content in a layer of 300mm adequately compacted, upto plinth level.

# CONSTRUCTION METHODOLOGY

(Cost Effective, Seismic Resistant Confined Masonry Building)

6

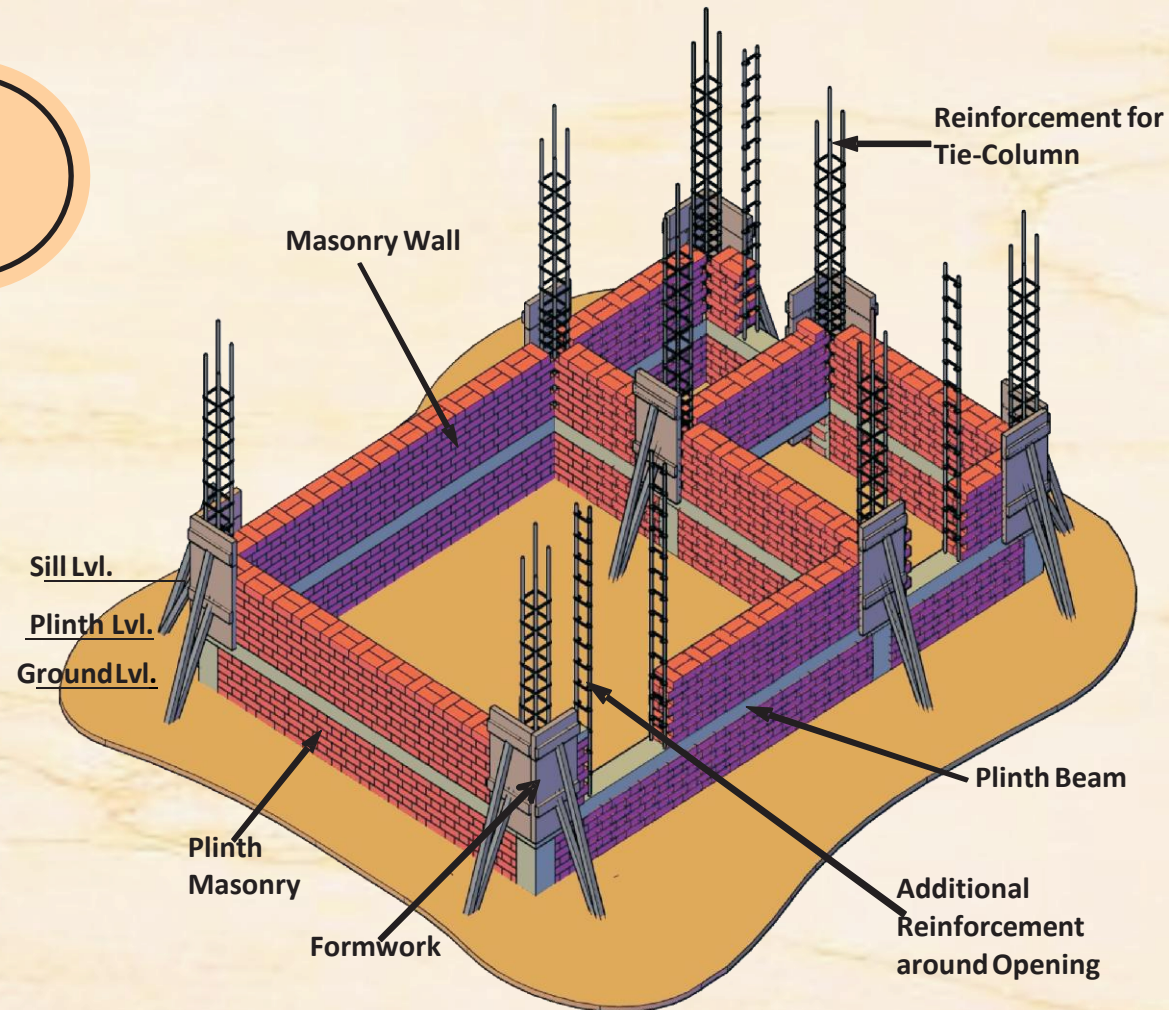


Construct sill masonry wall above plinth level, leaving openings for doors, as per architectural layout. Additional reinforcement detail, as shown in figure shall be provided around such openings.

# CONSTRUCTION METHODOLOGY

(Cost Effective, Seismic Resistant Confined Masonry Building)

7



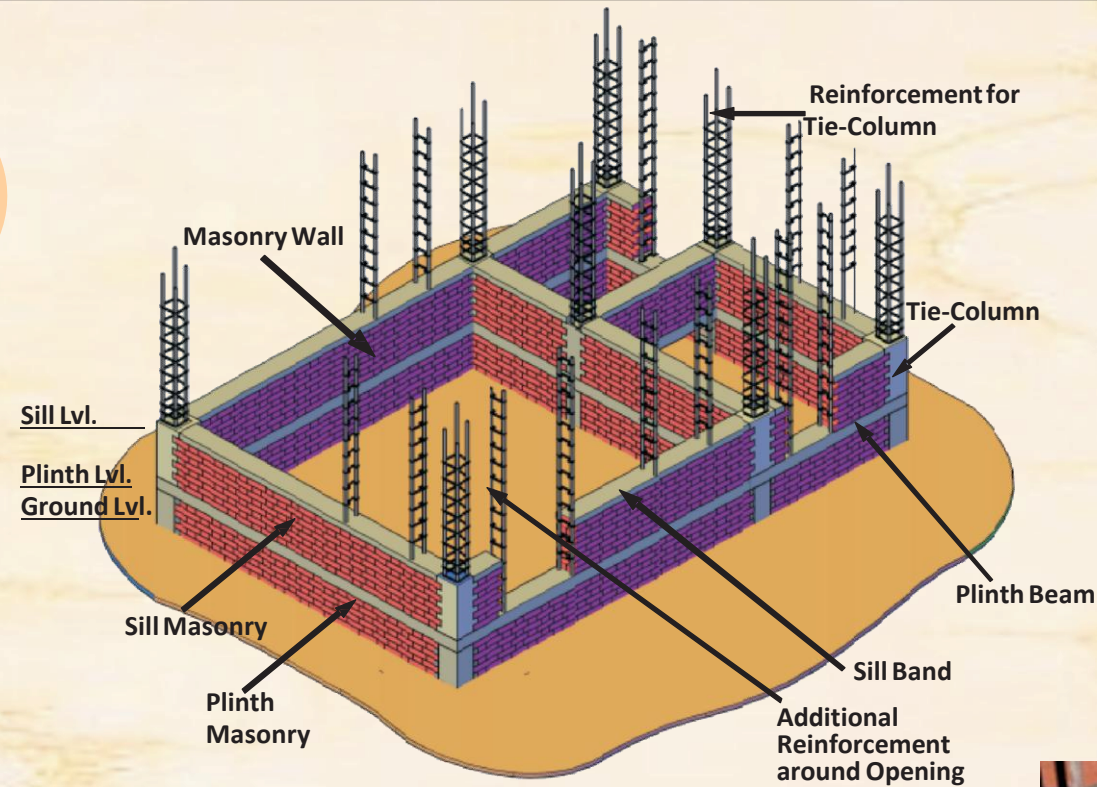
Prepare formwork for tie-columns upto the sill level, as shown.



# CONSTRUCTION METHODOLOGY

(Cost Effective, Seismic Resistant Confined Masonry Building)

8



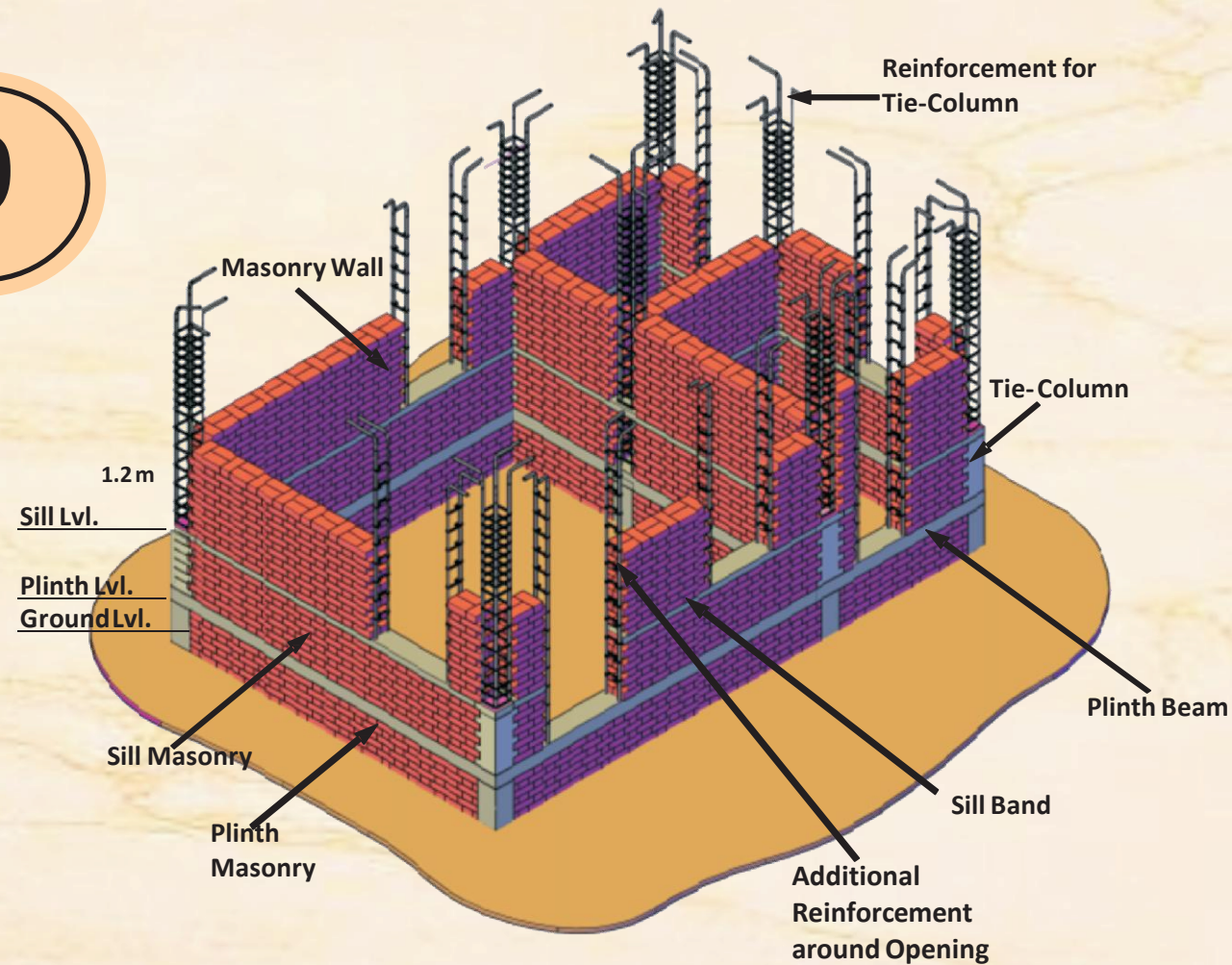
Cast tie-columns from plinth level upto the sill level. Also cast bond beam at sill level, if any. Provide vertical notch in green concrete of tie-column, as shown.



# CONSTRUCTION METHODOLOGY

(Cost Effective, Seismic Resistant Confined Masonry Building)

9



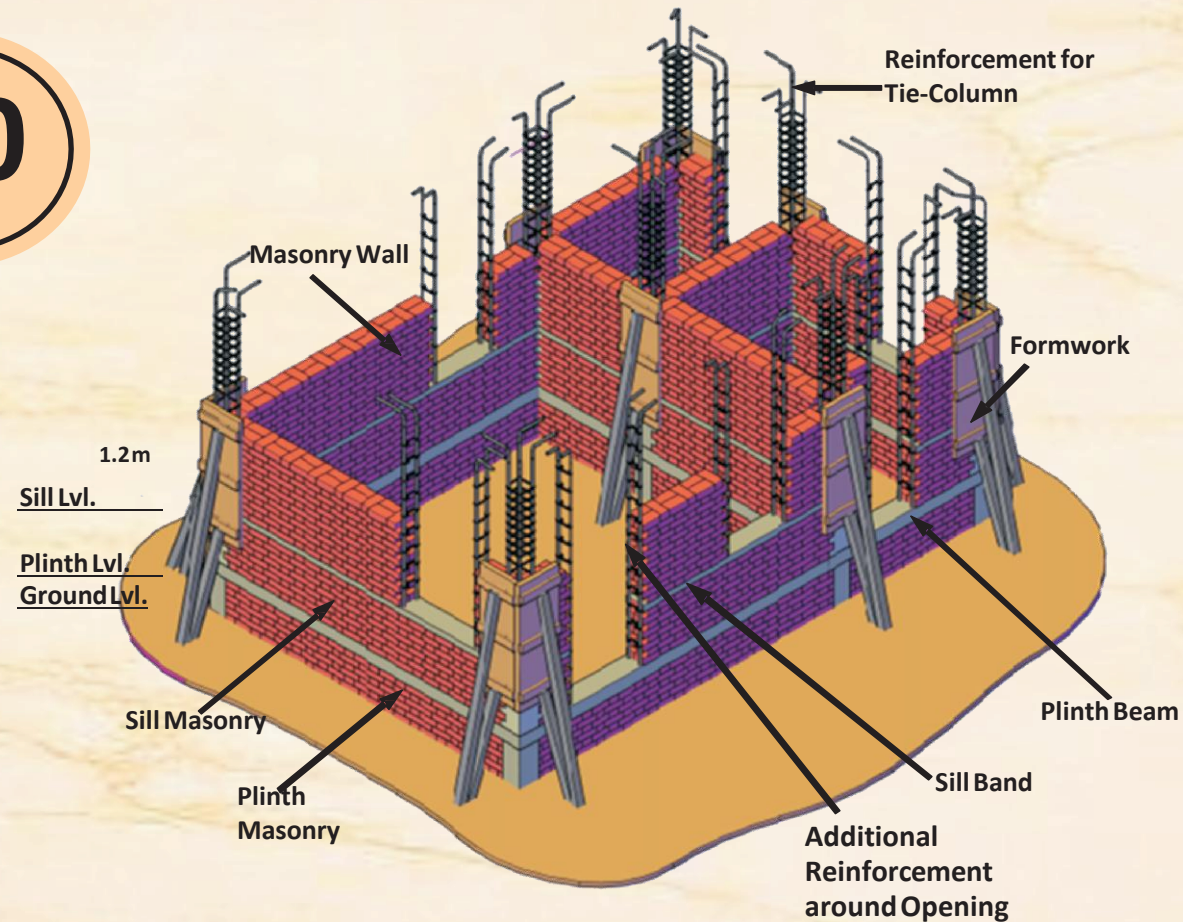
Construct wall-pier masonry above the sill level upto 1.2 m.



# CONSTRUCTION METHODOLOGY

(Cost Effective, Seismic Resistant Confined Masonry Building)

10



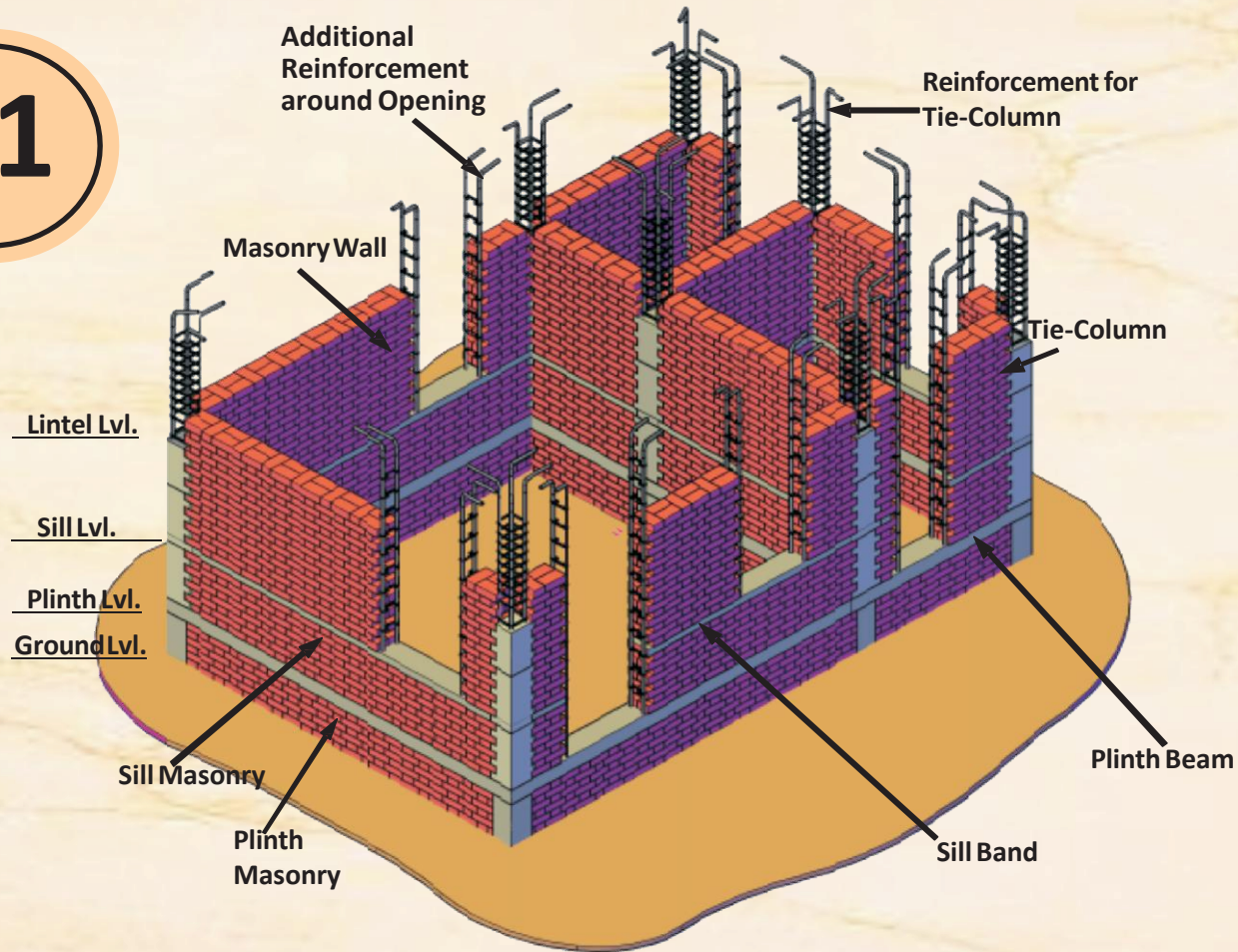
Provide formwork for tie-column above sill level and cast the concrete. Do not forget to provide notch in tie-column concrete in green state.



# CONSTRUCTION METHODOLOGY

(Cost Effective, Seismic Resistant Confined Masonry Building)

11

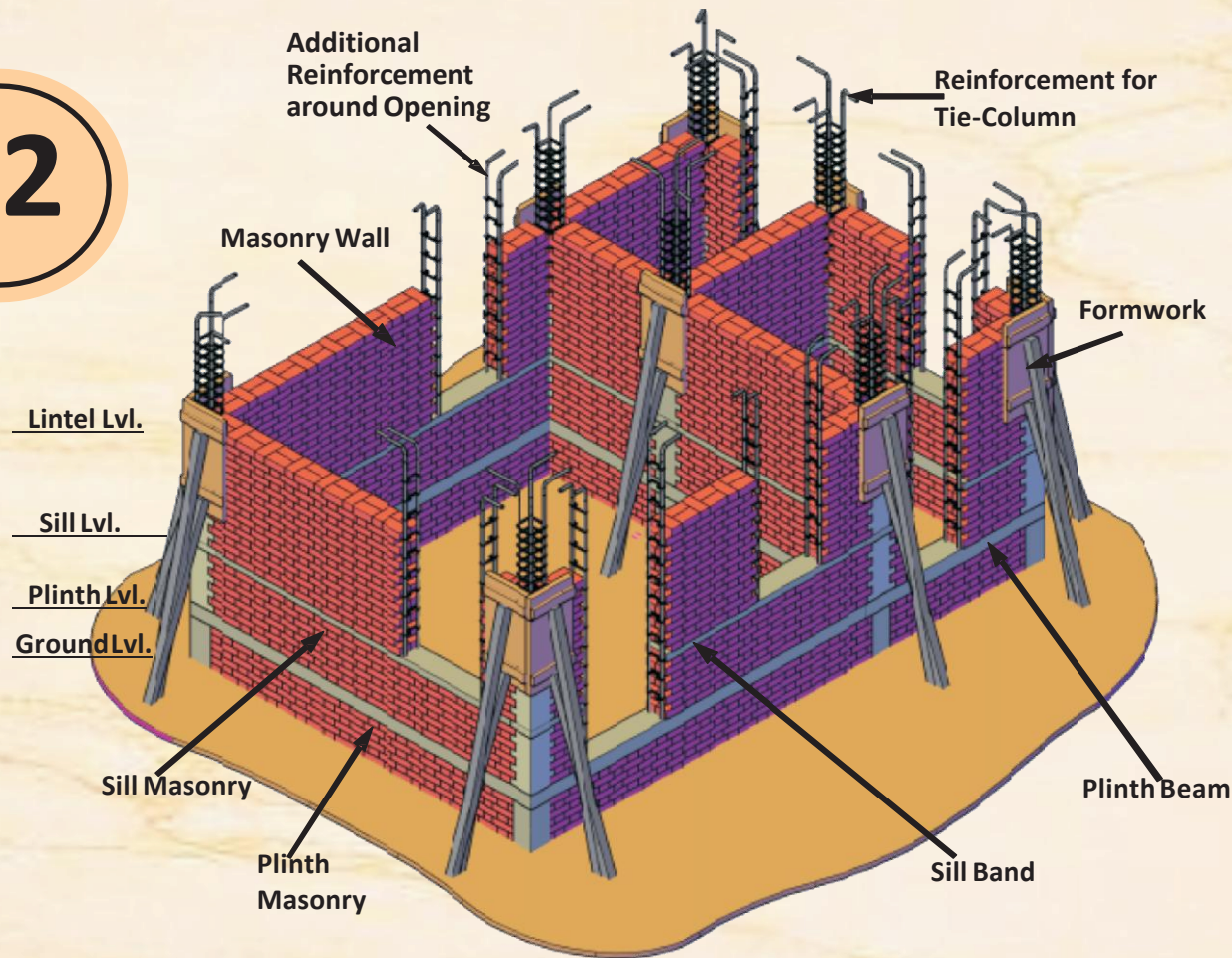


Further construct masonry walls upto the lintel level.

# CONSTRUCTION METHODOLOGY

(Cost Effective, Seismic Resistant Confined Masonry Building)

12



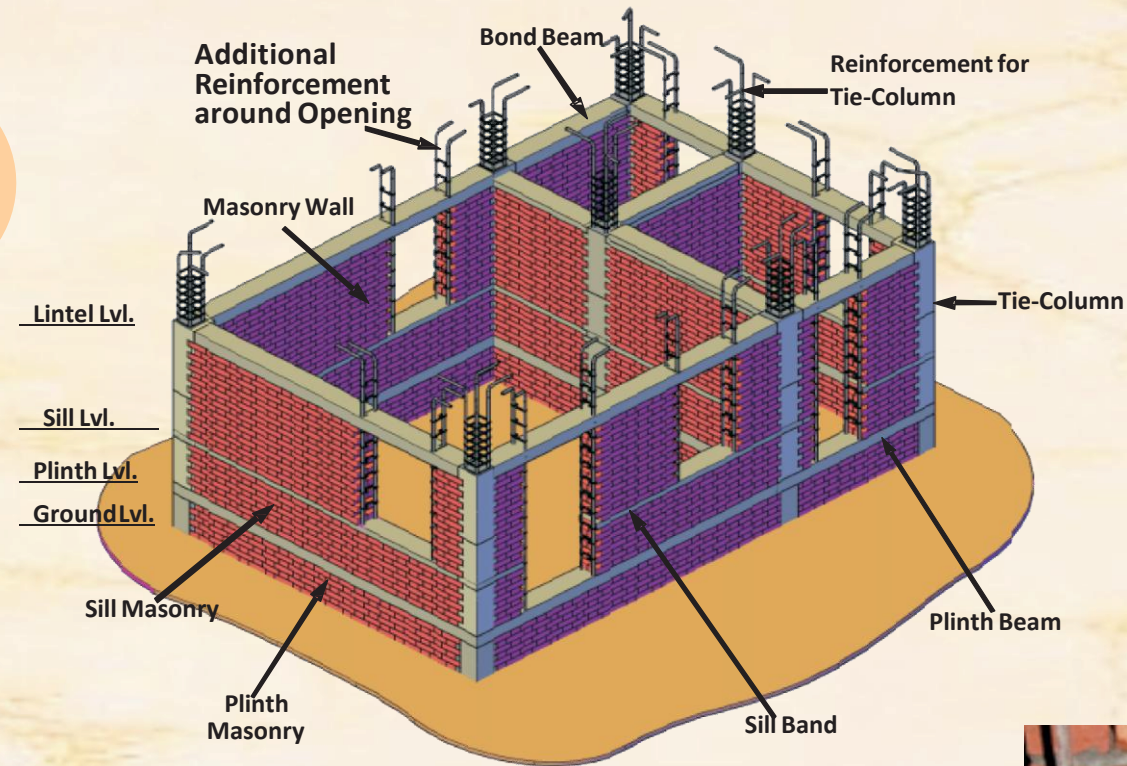
Provide formwork for tie-columns upto the lintel level. Cast concrete in tie-column.



# CONSTRUCTION METHODOLOGY

(Cost Effective, Seismic Resistant Confined Masonry Building)

13



Cast bond-beam on walls at one level. Ensure the reinforcement of bond beam passes through tie-column reinforcement. Provide additional reinforcement in bond-beam over openings.

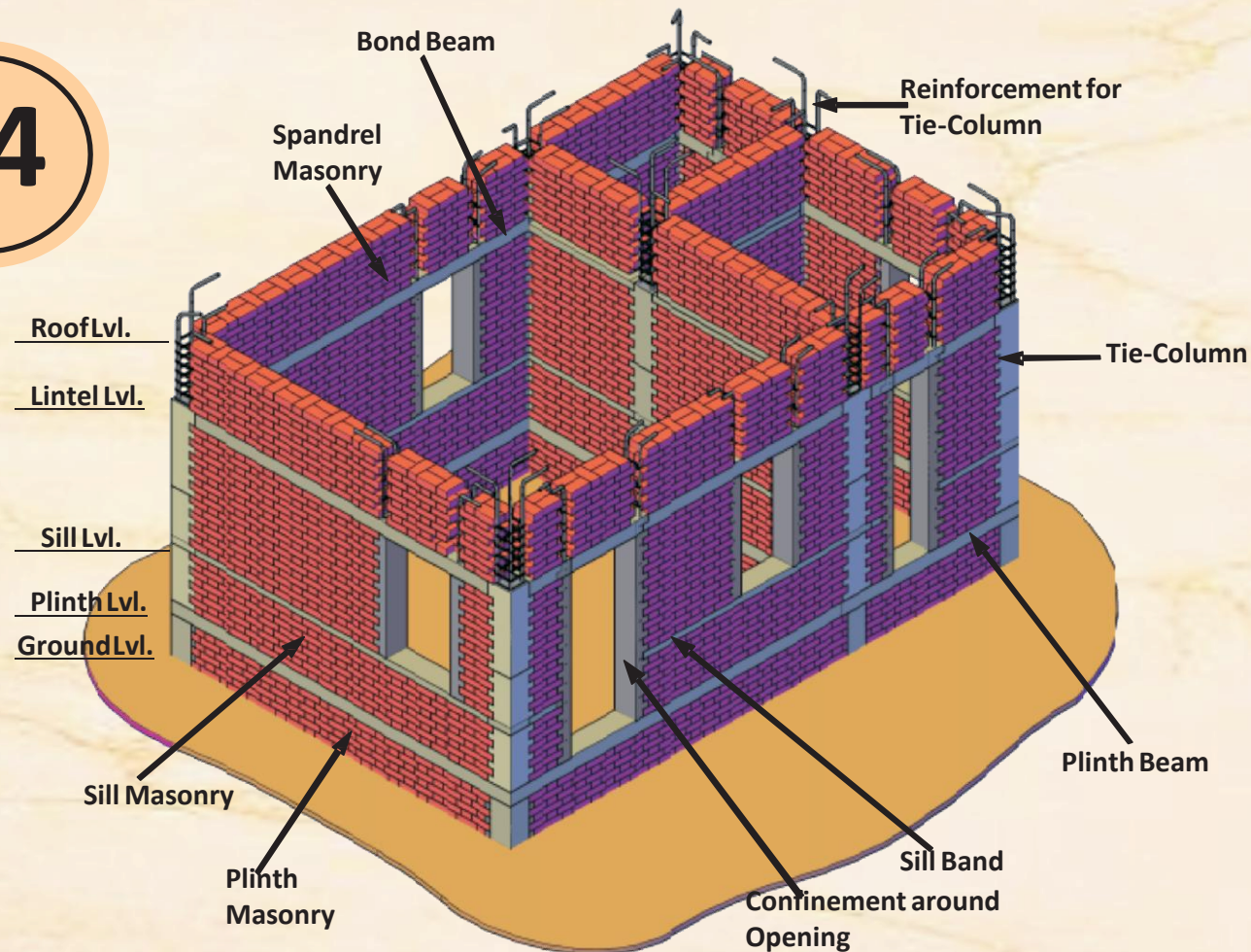




# CONSTRUCTION METHODOLOGY

(Cost Effective, Seismic Resistant Confined Masonry Building)

14

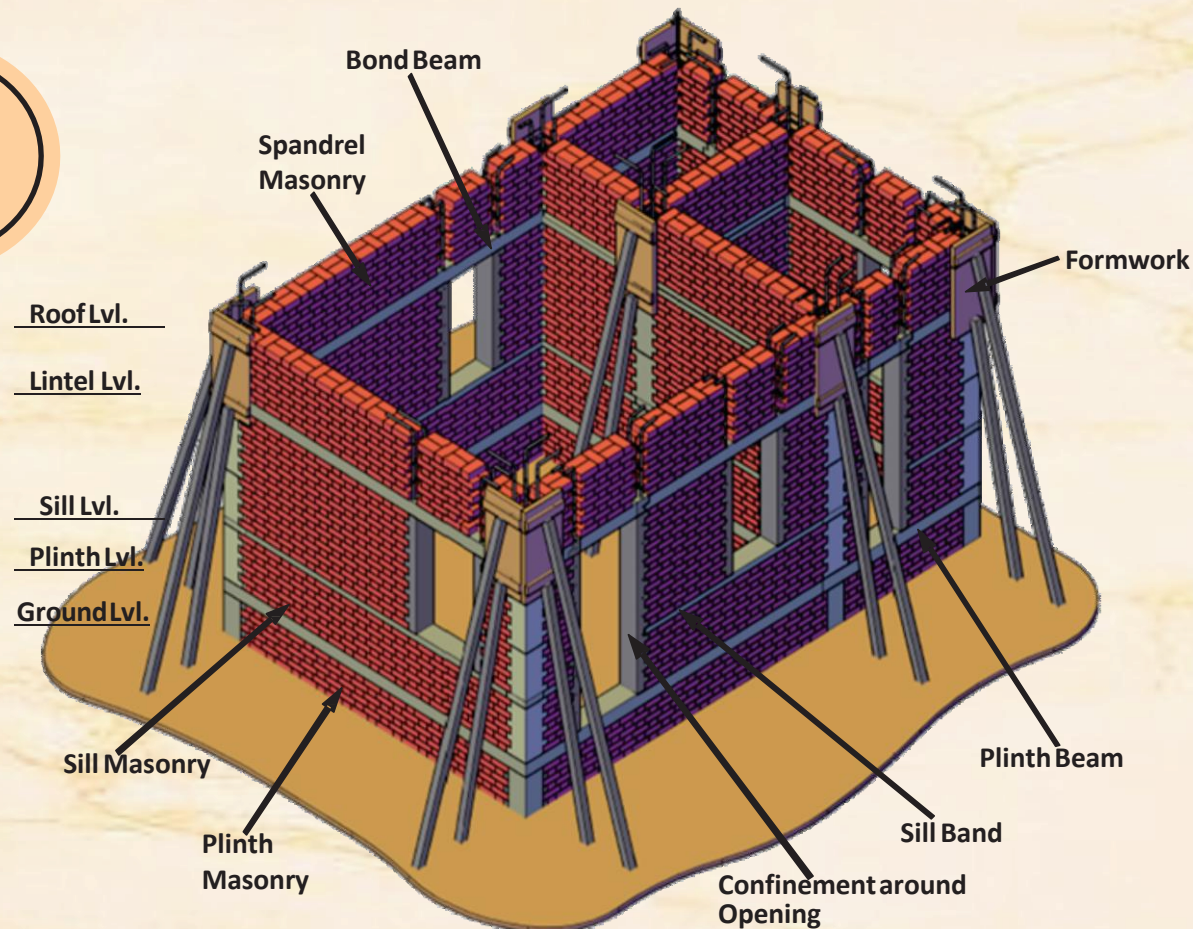


Construct spandrel masonry walls up to the slab level.

# CONSTRUCTION METHODOLOGY

(Cost Effective, Seismic Resistant Confined Masonry Building)

15



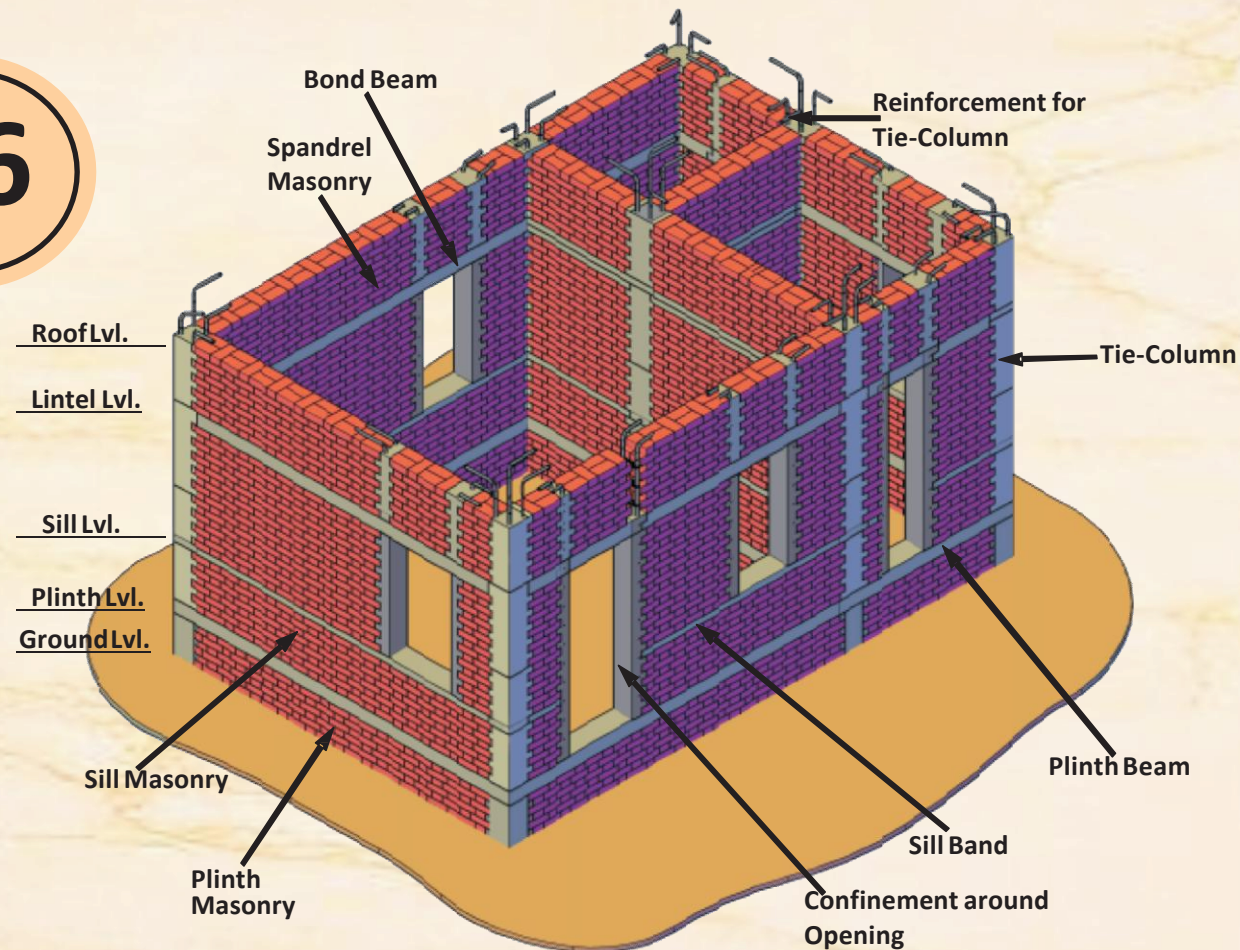
Provide formwork for tie-columns between bond-beam to slab level and cast concrete in tie-column. Bend the tie-column longitudinal reinforcement into slab, if tie-columns are to be terminated .



# CONSTRUCTION METHODOLOGY

(Cost Effective, Seismic Resistant Confined Masonry Building)

16



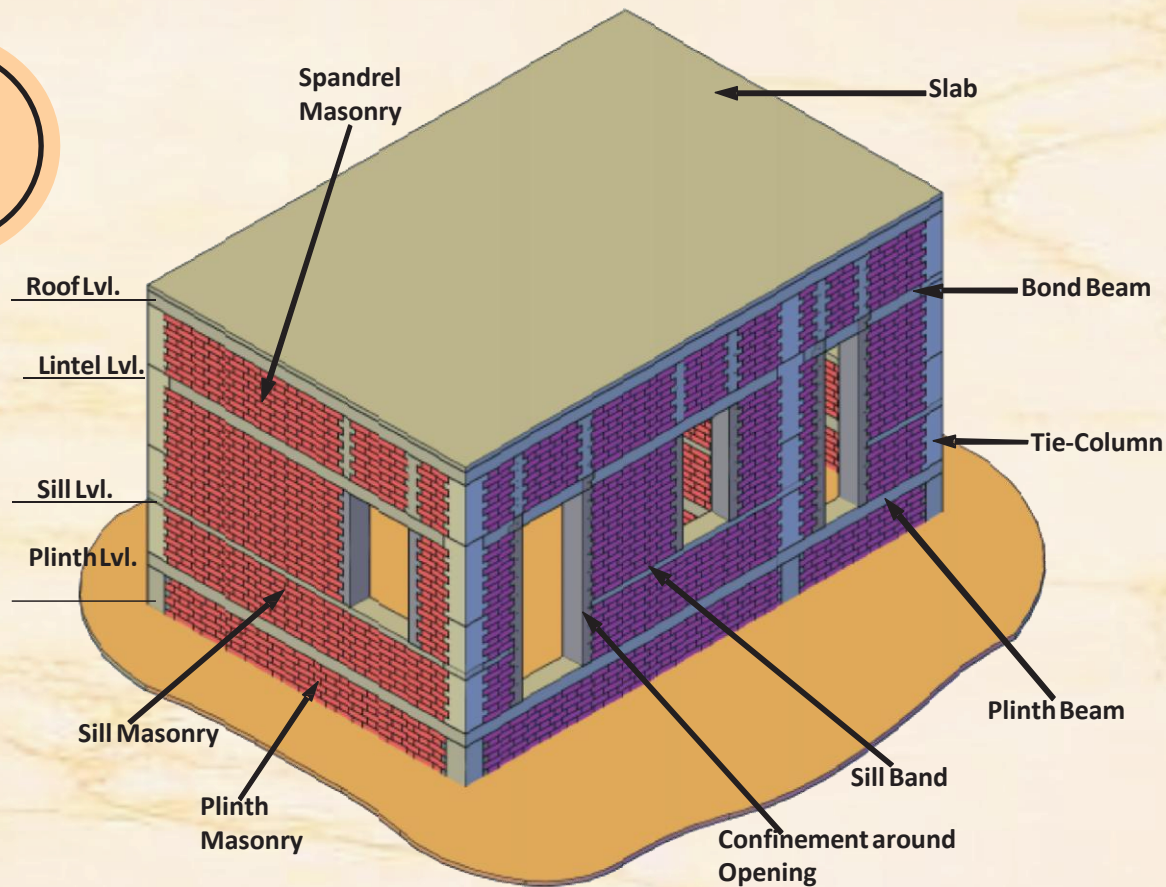
Also cast confinement around openings upto the slab level. Bend the longitudinal reinforcement of tie-columns into the roof slab.



# CONSTRUCTION METHODOLOGY

(Cost Effective, Seismic Resistant Confined Masonry Building)

17

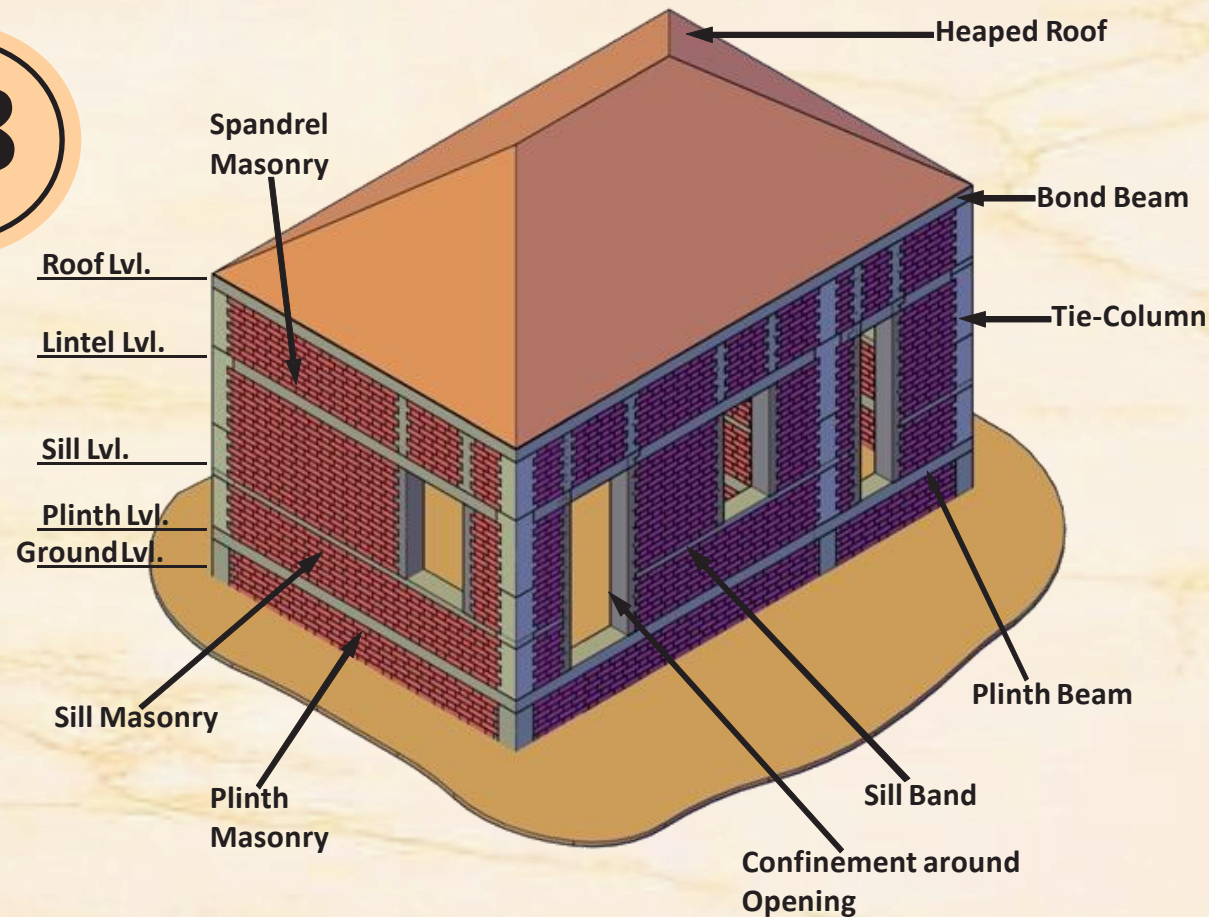


Cast RC slab as roof or floor. Note due to RC slab resting over spandrel masonry, no bond beam is required.

# CONSTRUCTION METHODOLOGY

(Cost Effective, Seismic Resistant Confined Masonry Building)

18



In case of pitched/heaped roof, there will not be RC slab, hence to embrace gable end and spandrel masonry, bond beam at roof level is to be provided.

# QUALITY ASSURANCE CHECKS

## MASONRY WORK

Description	Satisfactory/ Unsatisfactory	Remarks
Curing of masonry units.		
Distribution of masonry courses as per the height to be achieved for next level.		
Mortar mix as specified (1:3 for 115 mm thick walls and 1:6 for 230 mm thick walls).		
Joints thickness (not more than 12 mm).		
Vertical profile and flatness of wall.		
Reinforcement/Dowels in place, as per the specification (8 mm reinforcement bar after every 4 <sup>th</sup> course).		
Joints even and racked.		
Door/window openings as per drawing.		
Lintel beams provided as per drawing.		
Block work done in layers not exceeding 1.2 m.		
Unwanted particles are removed.		
Masonry date marked after end of day's work (for 7 days curing).		



# QUALITY ASSURANCE CHECKS

## PLASTER

Description	Satisfactory/ Unsatisfactory	Remarks
Double Scaffolding for plastering wall		
Wetting masonry surface before plastering		
Mortar mix as specified (1:3 for 115 mm thick walls and 1:6 for 230 mm thick walls)		
All holes and gaps are properly filled		
Under Coat : Plaster to be finished to a true and plumb surface and the surface shall be left rough and furrowed 2 mm deep		
Finishing Coat : Check final finish & grooves as per drawing		
Finished plaster has even surface and proper degree of smoothness		
Check work visually after completion for groove lines, joints, and sharpness of corners		
Mark the date after completion to have control over curing. The plaster to be kept wet for a period of 7 days		
Cleanliness and unwanted particles cleared away.		

# QUALITY ASSURANCE CHECKS

## ROOFING WORK

Description	Satisfactory/ Unsatisfactory	Remarks
Unwanted particles, dust, foreign material or any deposits of contaminants are removed.		
Required slope maintained.		
Diameter of rainwater pipe is more than 80 mm.		
Concrete is filled in the gap between hole and pipe.		
Anchor rods are placed to hold pipes in position.		
Conformity of thermal insulation and water proofing materials to relevant IS codes and contract specifications.		
The sides of khurras and sides of outlet are rendered, rounded and top structure of khurras as is lower than level of adjoining roof surface.		
The exposed surface of the gola is plastered with cement mortar or water proofing treatment as specified in contract.		
The finished surface is cured at least for 7 days.		

# QUALITY ASSURANCE CHECKS

## FLOORING

Description	Satisfactory/ Unsatisfactory	Remarks
Type, size, colour, quality etc. of tile/marble as per the specifications.		
Free from damage, scratches, cracks, chips & bubbles.		
Adhesive/ cement mix is proper		
Bedding layer of average thickness 20 mm provided with minimum thickness at any place not less than 12 mm.		
Prepared surface is clean and free from loose materials.		
Layout/ alignment is proper with levels marked for proper slope.		
Machine is used or cutting marble/ tiles for uniformity and edges are even and at right angle.		
Proper finishing around drains, switches & fittings is done.		
Regular & continuous joints with neat appearance.		
Tiles bedded & pointed in grout.		
In tiling work, grey cement slurry of honey like consistency is spread at the rate of 3.3 kg of cement /sqm.		
In tiling work, variation of individual dimension from average value of length/breadth not to exceed $\pm 0.5$ mm and tolerance in thickness $\pm 0.4$ mm.		



# QUALITY ASSURANCE CHECKS

## WATER PROOFING

Description	Satisfactory/ Unsatisfactory	Remarks
Existing surface is free from foreign particles, dust, organic matter etc.		
Sprinkling of water to make the surface saturated wet.		
First coat of tapecrete slurry (1 P-151 :2 cement) as per manufacturer's specification.		
Additional coat of tapecrete paste (1 P-151:2 cement:5 Silica sand) at corner junction, as per manufacturer's specification.		
Second coat of tapecrete slurry (1 P-151 :2 cement) as per manufacturer's specification.		
Third coat of tapecrete slurry (1 P-151 :2 cement) as per manufacturer's specification.		
The time gap between two subsequent coat be between 2-4 hrs. Thickness of all the three coats becomes 0.50mm.		
Finally, after 48 hrs., 12mm thick 1:4 protection plaster is done.		
Check, if all the pipe periphery are sealed with mortar.		
Check the result of hydro test and ensure that the record of hydro test are being maintained in proper format.		
Ensure that the filling in sunken portion is carried out very carefully.		

# QUALITY ASSURANCE CHECKS

## PAINTING WORK

Description	Satisfactory/ Unsatisfactory	Remarks
Scaffolding (if necessary) to be on double supports, but clear of all the walls.		
Pieces of old gunny bags tied on the top of ladders (if used) & legs of scaffolding.		
Surface to be painted is even and free from any kind of dirt.		
For painting of ceiling, proper stage scaffolding is provided.		
Paint is of approved colour, brand and company.		
At a time, only required and sufficient quantity of paint is prepared.		
The number of coats applied meet the specifications.		
1 <sup>st</sup> coat / Sealer coat.		
2nd coat / Mid coat.		
3rd coat / Finish coat.		
After the final coat, the surface presents a uniform appearance and desired finish.		

# QUALITY ASSURANCE CHECKS

## WOOD WORK

Description	Satisfactory/ Unsatisfactory	Remarks
Panels are of approved quality, thickness and type.		
Moisture content of timber is within specified limits.		
Test for moisture content on each lot is carried out.		
Wood preservative paint is applied wherever woodwork is in contact with the brick masonry or concrete.		
Flush door shutters from approved vendors and of correct dimensions.		
All wood work carried out as per the dimensions given in the drawings.		
Timber is always sawn in the direction of the grains.		
Rebates, rounding or moulding is done before the members are jointed into frames		





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